Space Weather Technical Forecast

Issued on Monday 20 January 2025 at 00:27 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares expected, with slight chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one M-class flare, peaking M2.4 at 19/0332 from AR3964 in the northwest. This is the most active of the nine regions currently on the Earth-facing disc, but has been showing some apparent weakening as it approaches the limb. The other regions have been less active with occasional C-class flares observed, although AR3959, just west of north-centre, produced a C8.2 flare at 19/1708 UTC. This is a large region dominated by a single leader with only small peripheral spots. AR3961 in the south-centre is the largest region on the disc, however this has remained magnetically simple and inactive. Some growth was observed in small spots in the southwest, southeast and northwest, however these remain magnetically simpler.

No Earth-directed CMEs were observed, however a filament eruption was observed southeast of centre disc around 19/2300 UTC. It is currently too early to ascertain if a CME was produced.

Solar Wind / Geomagnetic Activity: Ongoing fast winds from CH09/- were observed. Solar wind speed, as measured by ACE and DSCOVR was slightly elevated to elevated (450-530km/s). Density remained at or below average. Interplanetary Magnetic field, Bt, was Weak, mainly 5-8nT, with the north-south component also Weak, varying between +/- 8nT, but favouring a negative (southward) orientation. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3), but with Active (Kp 4) intervals 19/0600-0900UTC and 19/2100-20/0000UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at Background. High energy electron flux (greater than 2MeV) at GOES16 was mainly Moderate, peaking 791pfu at 19/1845UTC. The associated 24-hour fluence persisted below the Active threshold, reaching 2.32e7 integrated pfu at 20/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected, with isolated M-class flares and a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are no CME arrivals expected at Earth, however a glancing impact from the CME early on 18 Jan cannot be completely ruled out late on day 1 (20 Jan). Otherwise, current fast winds from CH09 are expected to continue before gradually easing

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from late day 2 (21 Jan) onward. Mainly Quiet to Unsettled geomagnetic activity is expected, with a chance of Active intervals.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to be at background, but with a slight chance of enhancement given the occurrence of any significant flares. GOES16 high energy electron flux is forecast to be Moderate, perhaps peaking at High, although the longevity of the periods of High is low confidence. The associated 24 hr fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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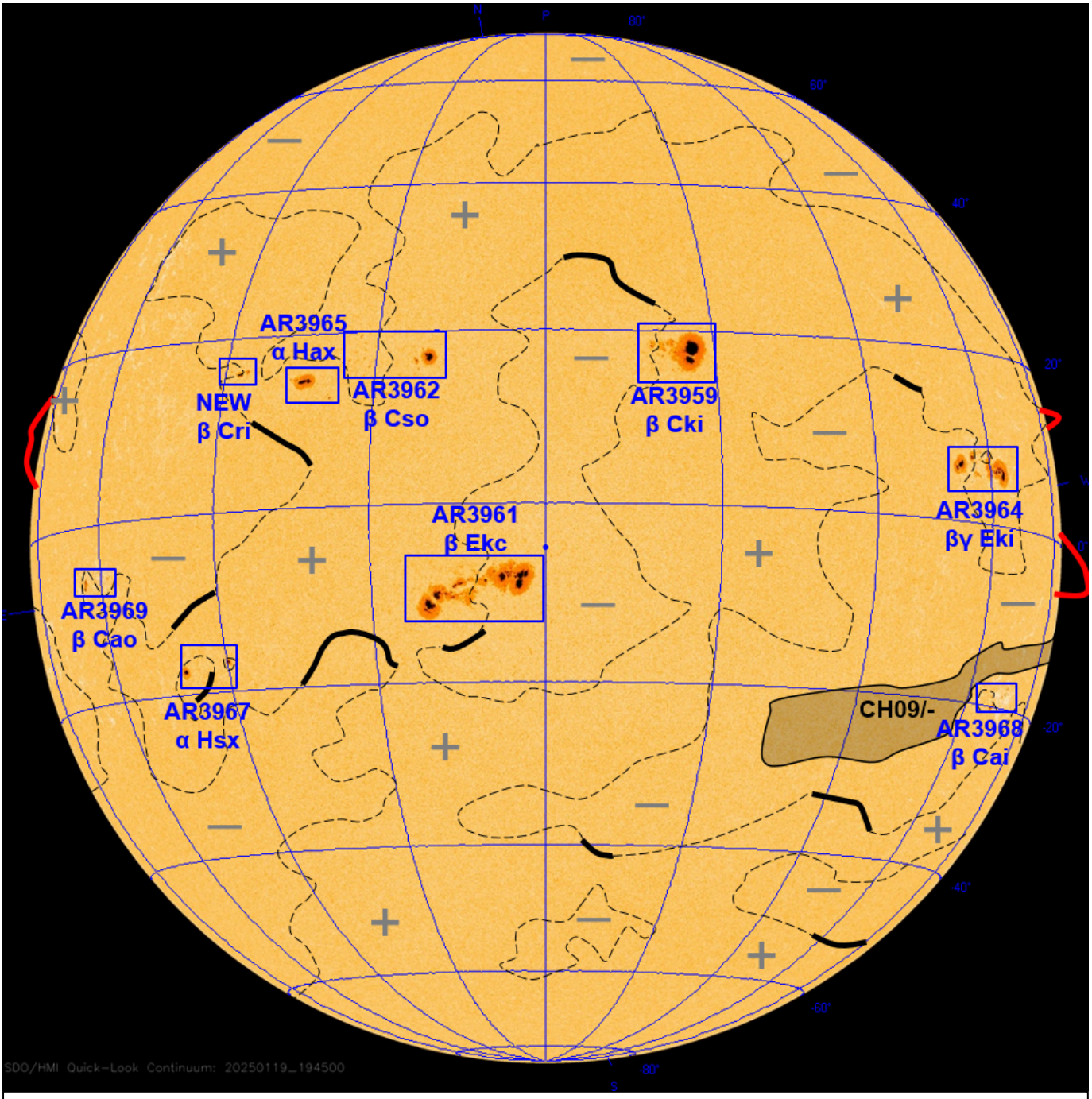
Figure 1: MOSWOC Solar Synoptic Map 19/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no CMEs expected to impact Earth. However a weak eruption from AR3964 early on 18 Jan is expected to pass close to Earth, likely just ahead and north of its orbit. This has a small chance to give a very slight glancing impact late on 20 Jan, as it passes nearby.

Solar winds are currently dominated by fast wind from the longitudinally wide CH09/-. Observed winds from this feature have peaked near 550km/s and persisted at slightly elevated to elevated (450-550 km/s) for a number of days. These fast winds are expected to continue of day 1 (20 Jan), before starting to erratically ease from later on day 2 (21 Jan). This prolonged feature is supported by MOSOWC Enlil, although this is overestimating the strength of the wind slightly and perhaps slightly too late with the declining wind.

Mainly Quiet to Unsettled geomagnetic activity is expected, with a chance of Active intervals. These most likely late on day 1 or day 2 (20-21 Jan), if any slight CME glance occurs.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	10	10	1	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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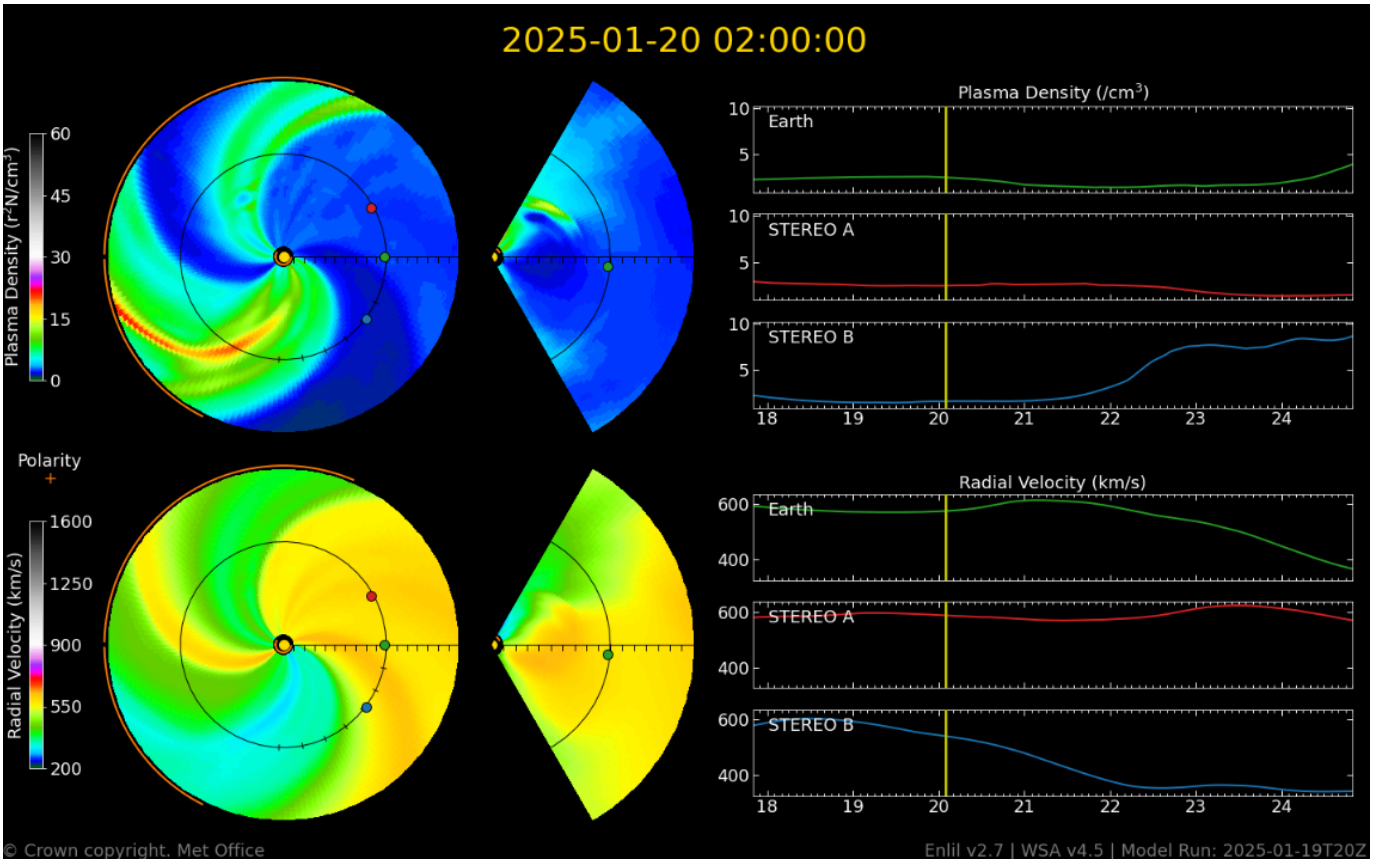
Figure 2: MOSWOC Enlil showing ongoing fast winds from CH09



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Radio Blackouts - X-Ray Flares

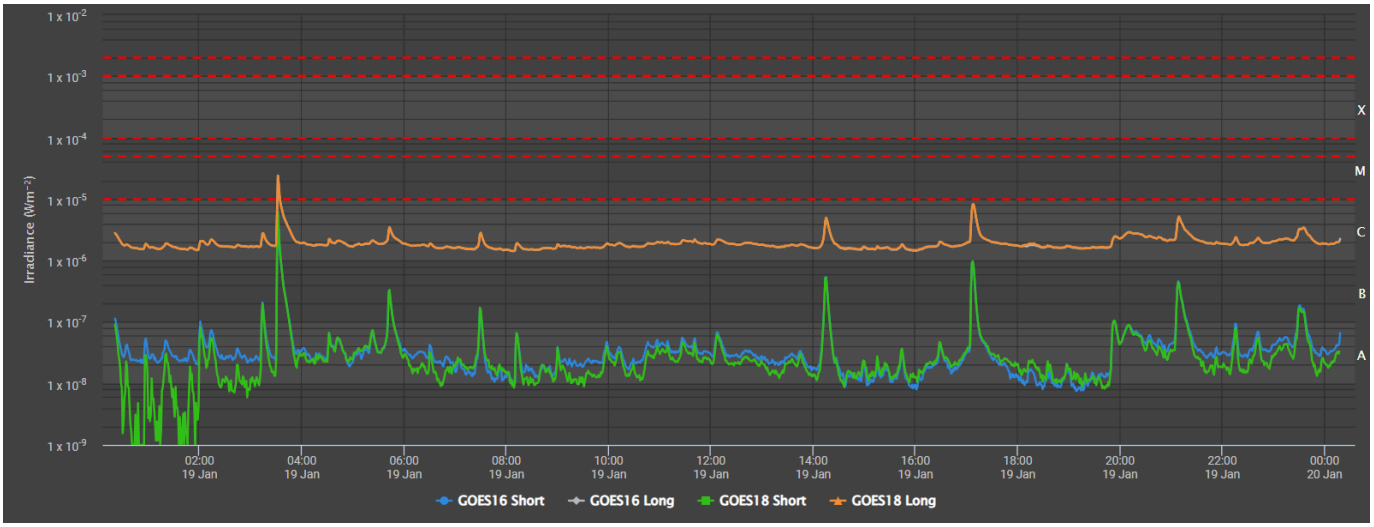
Moderate activity is expected to continue, with further isolated M-class flares expected and a slight chance of X-class flares.

There are nine sunspot regions currently on the disc, with the largest of these AR3961 in the south-centre disc. This region has seen some continual slow growth of penumbral extent, but is now showing signs of maturation and consolidation into a simple bipolar group. AR3964 in the northwest is historically the most active region, although this activity has recently faded as the spot lost its delta spot configuration. This region is showing some apparent decay, however this may be related to the regions increasing viewing angle. AR3959 is the next largest region, however this has persisted as a largely inactive spot dominated by its large leader, with only small peripheral spots. These three regions form the main risk of more significant flares on the disc, however given the magnetic simplicity of these regions, any flares are likely to be isolated.

Some growth has been evident elsewhere on the disc, including AR3968 in the southwest, AR3969 in the southeast and a new region in the northeast, While these are currently much smaller and simpler, further development is possible, with the potential for these to also be the source of isolated M-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	75	70	70
Very Active	R3-R5 (X Class)	No	15	15	10	10

Figure 3: GOES 16/18 X-ray Irradiance



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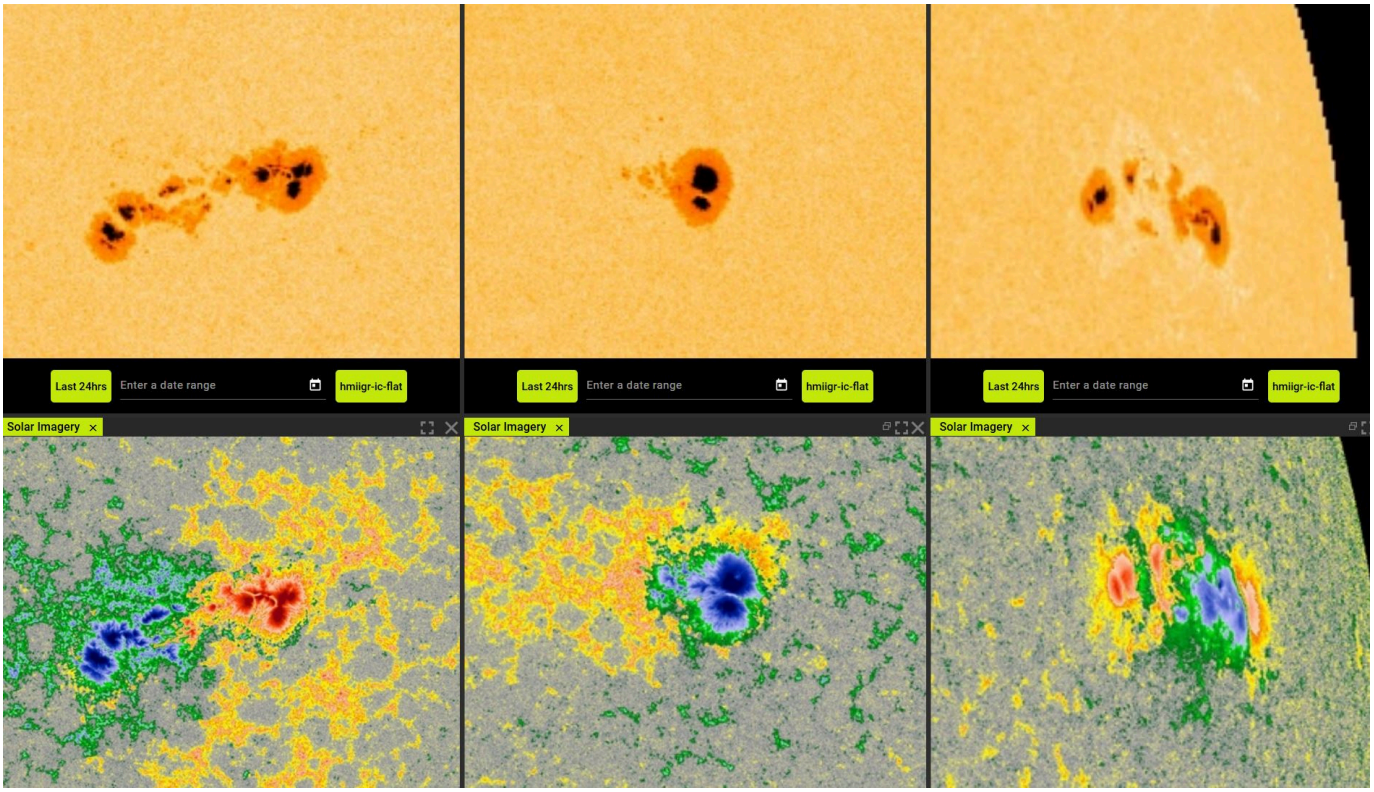
Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has persisted at Background. There is a slight chance of enhancement towards the S1 Minor Radiation Storm threshold given any notable flares. This includes any activity from AR3964 which is in a better connected location on the northwest disc, or from AR3961 in the southeast. AR3959 in the north, while currently less likely to produce notable flares, has a strong magnetic field suggesting that this is also a potential source should any destabilisation of this region occur.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO Intensity (top) and Magnetogram (bottom) imagery for AR3961, AR3959 and AR3964 (left to right)



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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has persisted at Moderate as a result of the recent extended period of slightly elevated to elevated solar winds. As these winds ease, any charging of the Radiation Belt at MEO is likely to expand outward, with the diurnal peak period at GEO likely to reach High. However, the longevity of these periods of High flux is currently low confidence due to the lack of any notable geomagnetic activity leading to some uncertainty with the extent of any charging. Furthermore, there is a slight chance of a glancing CME arrival late on day 1 (20 Jan), which could help to drop out the observed flux at GEO.

Subsequently, the associated 24 hr fluence is most likely to stay below the Active (1e8 integrated pfu), but with a very gradual rising trend. MOSWOC REFM supports this rising trend, and is currently giving reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	5	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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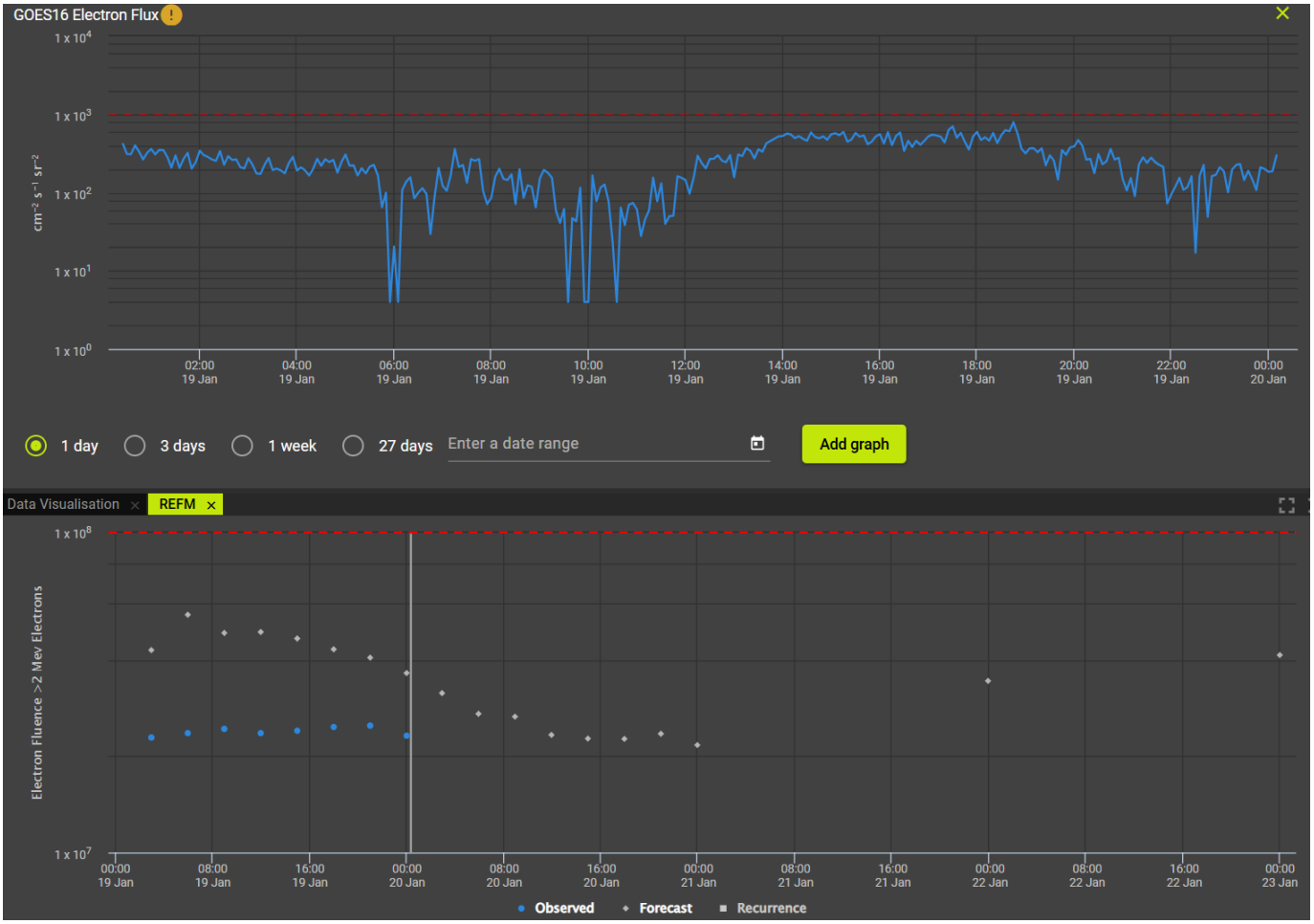
Figure 5: GOES 16 >2MeV Electron Flux (top) and associated 24 hr Fluence with REFM (bottom)



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